SB761
U7R6
79-14

Forest Insect and Disease Management

3430
BIOLOGICAL
EVALUATION R2-79-14

WESTERN SPRUCE BUDWORM

Results of an Egg Mass Survey on the Pike and San Isabel, an Arapaho and Roosevelt National Forests in 1979

Rocky Mountain Region

ROCKY MOUNTAIN STATION
JAN 30 1980
LIBRARY

U.S. Department of Agriculture Forest Service

3430
BIOLOGICAL
EVALUATION R2-79-14

WESTERN SPRUCE BUDWORM

Results of an Egg Mass Survey
on the Pike and San Isabel, and
Arapaho and Roosevelt National
Forests in 1979

PREPARED BY: James P. Linnane

James P. Linnane
Entomologist

APPROVED BY:

G. L. DOWNING
Staff Director
Forest Insect and Disease Management

LARRY D. HENSON
Deputy Regional Forester
State and Private Forestry

Forest Insect and Disease Management
State and Private Forestry
Rocky Mountain Region
USDA Forest Service
11177 W. 8th Avenue
Lakewood, Colorado 80225

ABSTRACT

The western spruce budworm defoliated over 900,000 acres of forest land in the Front Range of Colorado during 1979. Egg mass surveys were conducted on the Pike and San Isabel, and Arapaho and Roosevelt National Forests. Defoliation on the San Isabel National Forest is predicted to be light in 1980. Moderate to heavy defoliation is expected on the Pike National Forest in 1980. The Arapaho and Roosevelt National Forests should experience moderate to heavy defoliation during 1980.

INTRODUCTION

The western spruce budworm is the most serious defoliator in Douglas-fir and white fir timber types in the Rocky Mountain Region. Periodic epidemics have caused widespread and occasionally severe defoliation. Since 1974, Douglas-fir and white fir stands on the Pike and San Isabel National Forests and Douglas-fir stands on the Arapaho and Roosevelt National Forests have been sustaining damage from epidemic budworm populations.

Forest Insect and Disease Management monitors the western spruce budworm through annual aerial detection and egg mass surveys. Annual surveys are conducted to provide historical records of the activity of the western spruce budworm within the Region and to provide concerned land managers with information on the distribution and damage caused by the insect. In addition future activity is forecast.

Egg mass sample locations were determined at the discretion of FI&DM personnel with limited input from the Forest. Not all budworm infested areas within the Region were sampled in 1979 because of constraints on time and manpower. However, should the need to sample additional areas be identified, the sampling schedule for 1980 could be adjusted to accomplish this objective.

The egg mass surveys described in this report were conducted on the Pike and San Isabel, and Arapaho and Roosevelt National Forests in August 1979.

In conjunction with monitoring budworm populations through aerial and ground surveys, FI&DM has undertaken a special project to assess the damage to Front Range forests caused by the western spruce budworm. The purpose of this project is to estimate the amount of tree mortality, growth loss, and damage to understory regeneration caused by the budworm. When completed, this information should be of value to land managers.

BIOLOGY OF THE WESTERN SPRUCE BUDWORM

The western spruce budworm, *Choristoneura occidentalis* Freeman, is a principal defoliator in spruce-fir forest types in the West. In Colorado, the budworm's preferred hosts are Douglas-fir,

Pseudotsuga menziesii (Mirb.) Franco, and white fir, *Abies concolor* (Gord. and Glend.) Linbl.. Subalpine fir, *A. lasiocarpa* (Hook.) Nutt., Engelmann spruce, *Picea engelmannii* Parry, and blue spruce *P. pungens* Engelm., are also attacked.

The western spruce budworm has one generation per year in Colorado. Adult moths emerge and mate in July. Females may lay a partial compliment of eggs shortly after mating, the remainder are deposited after a migration period. Eggs are deposited in masses cemented to the undersides of host tree needles and hatch in ten days. The newly hatched larvae do not feed, but seek hiding places under bark scales on branches, in twig crotches, or among lichens where they spin silken shelters (hibernacula) and overwinter.

In the spring, larvae disperse to the foliage where they mine needles for one to two weeks. About the time buds begin to expand, larvae move into the buds and later, as the new shoots expand, spin loose feeding webs between shoots. Larvae prefer to feed on new foliage and become full grown in 30 to 40 days after feeding begins in the spring. Pupation takes place in feeding webs or on the foliage. Adult moths are not strong flyers, but may be carried considerable distances by air currents.

EXTENT OF THE OUTBREAK

Budworm occurs in all Douglas-fir, true fir, and spruce-fir forest types within the Region. The largest contiguous outbreak occurs on the Front Range of Colorado, principally on the Pike and San Isabel, and Arapaho and Roosevelt National Forests (Figure 1.). In 1979, over 900,000 acres were infested by budworm. Lesser outbreaks occur west of the Continental Divide in Colorado on the San Juan and Gunnison National Forests. This evaluation concerns only the Front Range outbreak on national forest land.

HOST STAND CONDITION

Mature stands of mixed Douglas-fir and white fir in the southern Front Range and Douglas-fir in the northern Front Range have suffered extensive and occasionally severe defoliation (up to 100% of new growth) since 1974. The severity of tree damage caused by

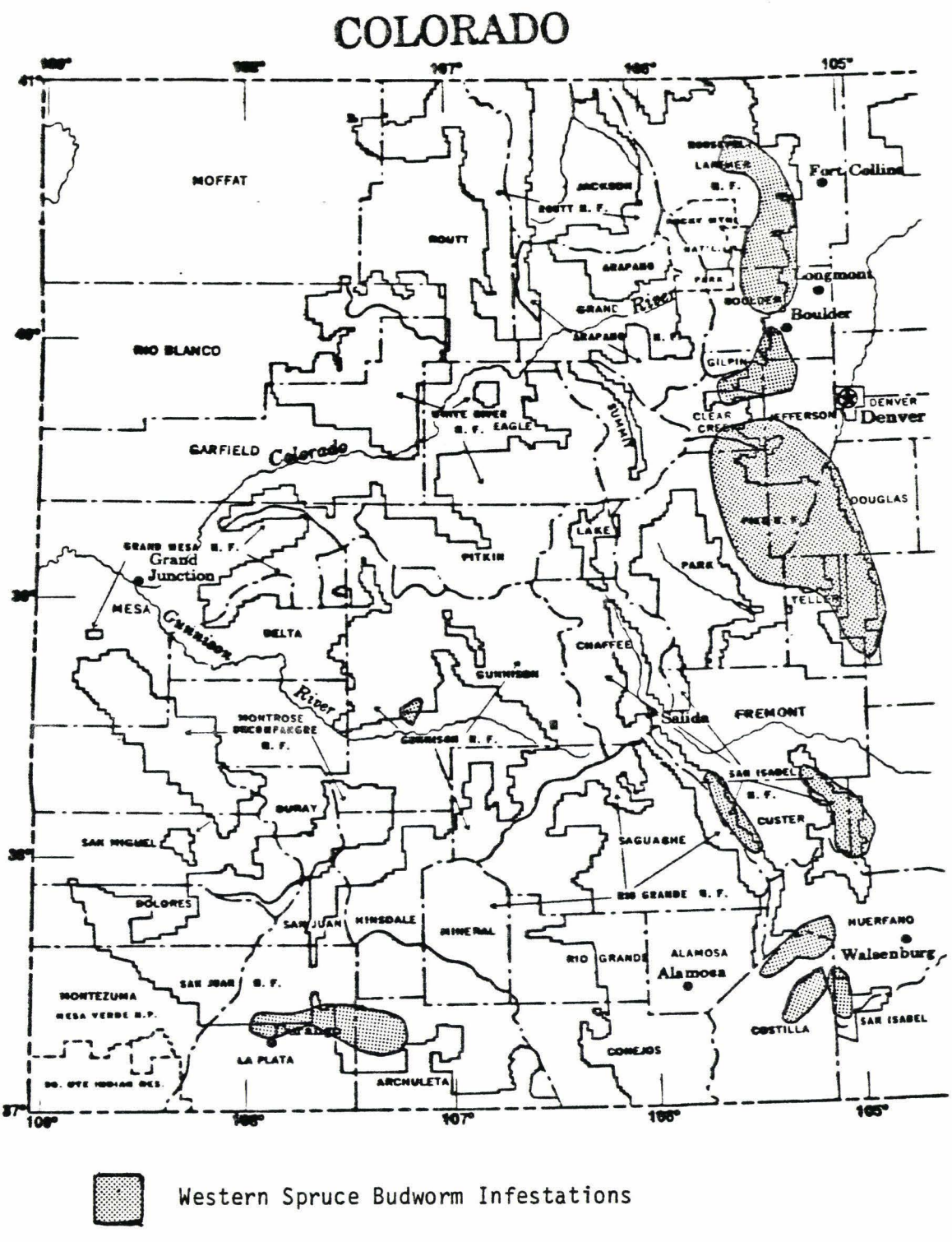

FIGURE 1. Western Spruce Budworm Infestations in Colorado during 1979.

the western spruce budworm is directly related to the intensity and duration of defoliation. Stands displaying good vigor and growth can withstand occasional or possible one or two consecutive years of heavy budworm feeding without significant injury. However, stands displaying poor vigor and growth (overmature and over-stocked stands) will suffer varied amounts of tree injury depending on the intensity and duration of defoliation. Generally, budworm infestations cause varied amounts of tree deformity, seedling damage, seed destruction, and stand regeneration failure. Stands subjected to three and possibly four or more consecutive years of severe defoliation may incur top-killing, and an indeterminate amount of tree mortality principally in the smaller size class trees (< 5" d.b.h.). Radial growth of defoliated trees may be reduced through the duration of the infestation.

EVALUATION METHODS

Egg mass surveys are the principal tool in evaluating budworm population trends and subsequent defoliation. The survey consists of sampling individual trees to estimate budworm egg mass density and defoliation. Sampling is accomplished using a fixed plot, cluster sampling scheme.

Sample plots were located on national forests within budworm infested areas. Plots consisted of three dominant or co-dominant Douglas-fir within close proximity. Two 27 inch foliated branches were pruned from the midcrown of each sample tree for a total of six branches per plot. These foliage samples were bagged, labeled, and transported to a lab to determine new egg mass densities. New and old egg masses were separated under a microscope. Current year's defoliation estimates were made by examining 100 new shoots from each sample tree. Egg mass and defoliation data were compiled and analyzed using a computer program developed by the Forest Service, Methods Application Group, Davis, California.

Defoliation predictions are based on estimates of egg mass densities. Defoliation classes and corresponding egg mass densities are reported in Table 1. These classes are adopted from McKnight (1967) and refined based on three years data from the fixed plot, cluster tree sampling scheme.

TABLE 1. Defoliation Prediction Classes for Western Spruce Budworm Egg Mass Sampling in Colorado.

Class	Mean Number of New Egg Masses per Square Meter Foliage	Defoliation Prediction [1/]
1	1.6 or less	Undetectable
2	1.7 to 10.0	Light
3	10.1 or more	Moderate to Heavy

[1/] Defoliation expected on new growth only

Undetectable --	0 - 10%
Light	10 - 35%
Moderate	35 - 65%
Heavy	65 - 100%

RESULTS

San Isabel National Forest. The forest was divided into three entomological units for budworm evaluation purposes; Wet Mountains, Spanish Peaks, and Sangre de Cristo Mountains (Figure 2). The Wet Mountain unit was intensively sampled in the vicinity of Beulah, Oak Creek, and Ophir Creek. Results of the survey are presented in Table 2.

Defoliation was light in all areas surveyed in 1979. Egg mass densities appear to have increased slightly over 1978. Defoliation in 1980 should again be light with the exception of the Spanish Peaks area. This area shows a dramatic increase in egg mass densities over 1978 (0.7 in 1978 to 25.8 egg masses/m^2 foliage in 1979). Although based on a small sample size, defoliation in the Spanish Peaks area may be moderate to heavy. The increase in egg mass densities may be the result of adult dispersal. Areas on the west side of LaVeta Pass and in Forbes Park have been heavily defoliated by the budworm during the past few years, more so than areas on the east side, particularly during 1977 and 1978. Possibly, budworm adults were carried over the Pass and Sangre de Cristo Mountains by westerly winds and dispersed into the Spanish Peak area.

Pike National Forest. Visible defoliation on this Forest remained near 1978 levels. The 1979 egg mass survey was conducted in the general area east of the South Platte River from the northern boundary of the Forest south to Colorado Springs. Areas in the vicinity of Indian Creek campground, Little Scraggy Peak, and Ormes Peak were intensively sampled (Figure 3). Sampling results are presented in Table 3.

Egg mass densities increased slightly over 1978. Defoliation may be moderate to heavy in 1980. Tree damage does not appear to be severe, however, the budworm will be entering its fourth year of increased activity in 1980.

Roosevelt National Forest. In recent years, the western spruce budworm has caused extensive and occasionally severe defoliation on this Forest. Eighteen locations were sampled in 1979. In addition, three areas were intensively sampled, Big Elk Meadows, Johnny Peak area, Magnolia, and Devil's Gulch (Figure 4). Sampling results are presented in Table 4.

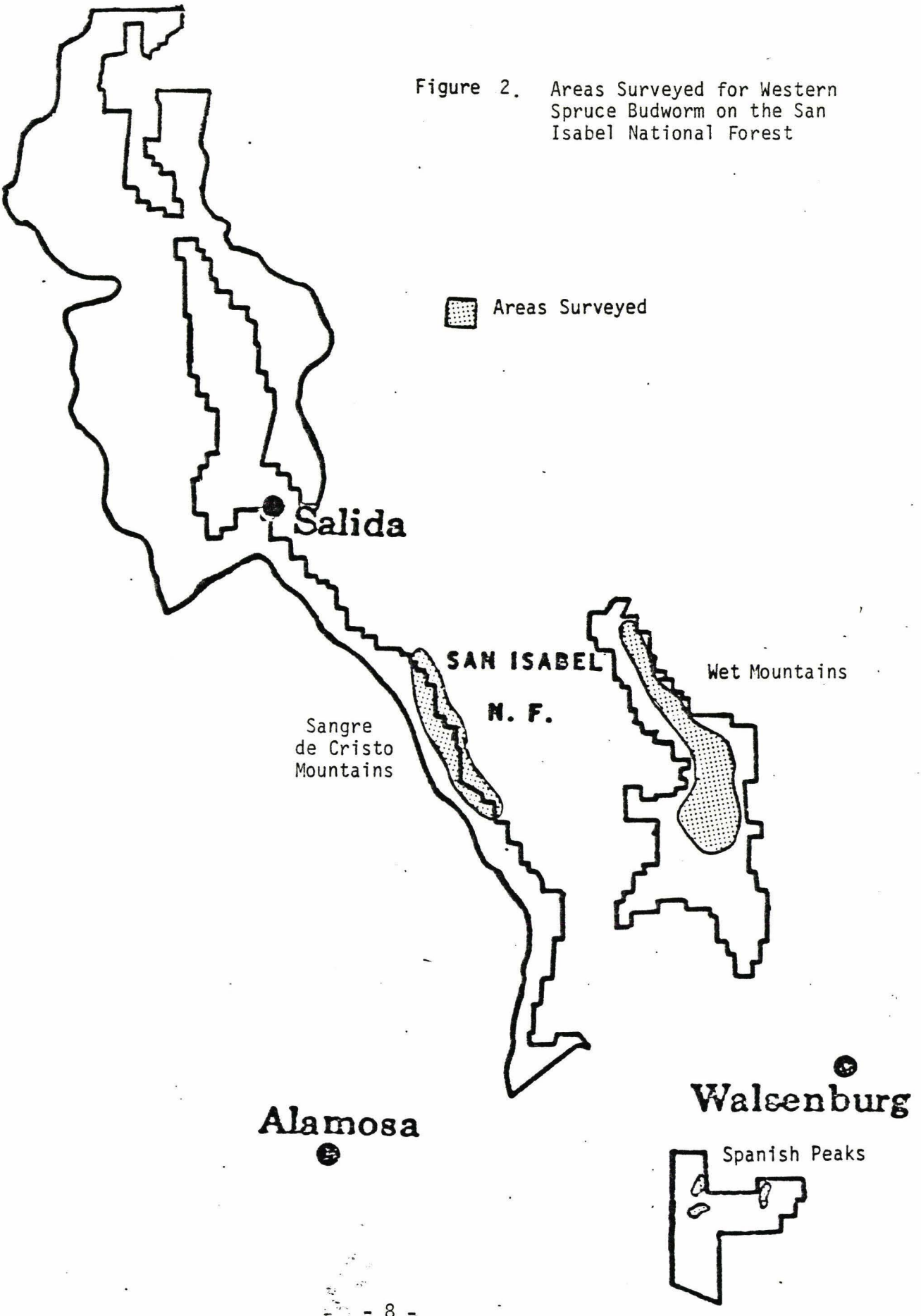

Figure 2. Areas Surveyed for Western Spruce Budworm on the San Isabel National Forest

TABLE 2. Results of Western Spruce Budworm Egg Mass Sampling on the San Isabel National Forest

Area [1]	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage	1979 Defoliation Estimate	1980 Defoliation Prediction [2]
Wet Mountains				
Beulah	60	2.4	Light	Light (Class 2)
Oak Creek	30	0.8	Light	Undetectable (Class 1)
Ophir Creek	12	7.9	Light	Light (Class 2)
Spanish Peaks	18	25.8	Light	Moderate to Heavy (Class 3)
Sangre de Cristo Mountains	18	4.9	Light	Light (Class 2)
SUMMARY	138	5.9	Lgiht	Light (Class 2)

[1] See Figure 2 for survey locations

[2] Table 1 explains defoliation classes

Figure 3. Areas Surveyed for Western Spruce Budworm on the Pike National Forest

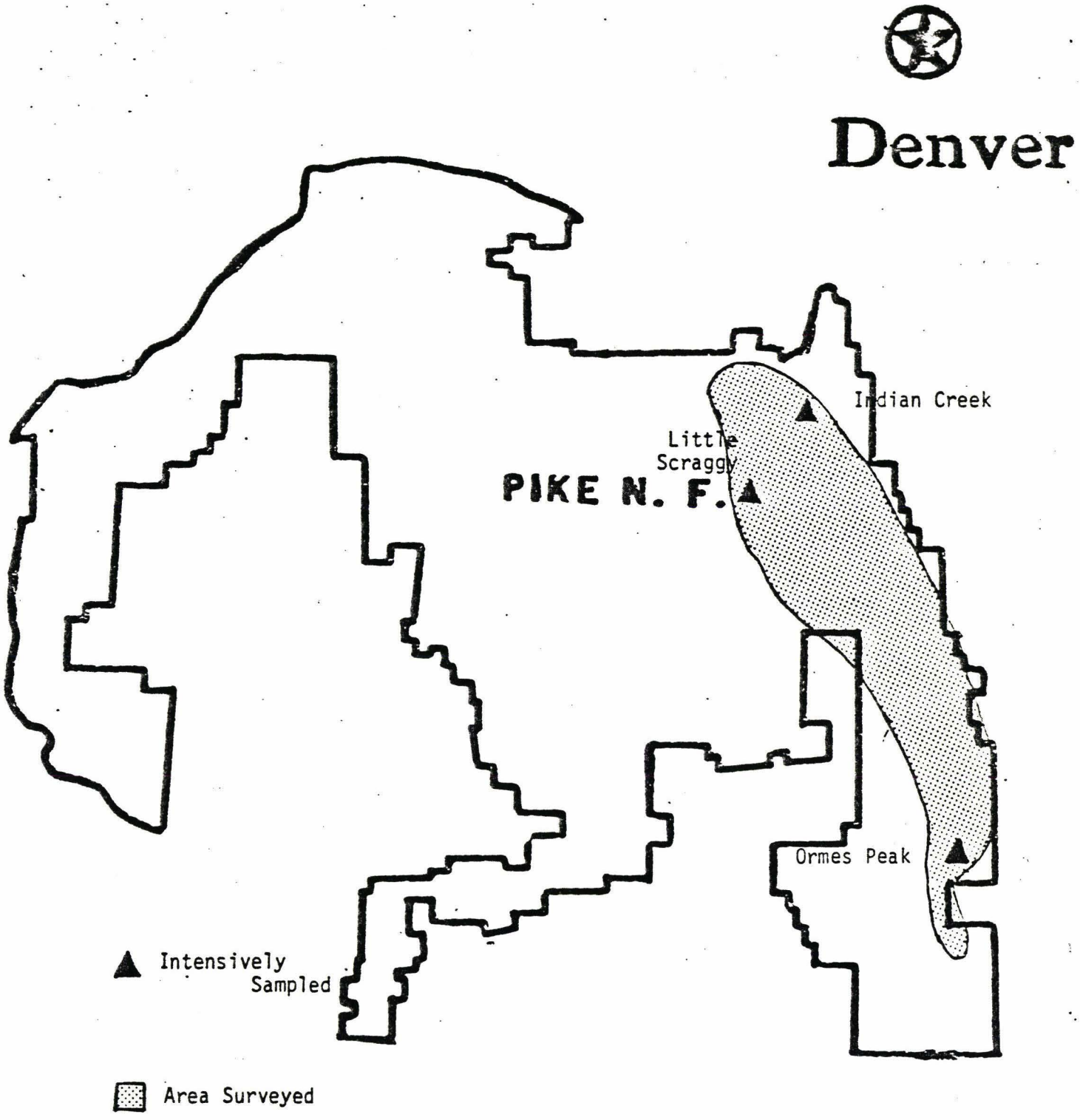

TABLE 3. Results of Western Spruce Budworm Egg Mass Sampling on the Pike National Forest

Area [1]	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage	1979 Defoliation Estimates	1980 Defoliation Prediction [2]
Little Scraggy Peak	90	28.5	moderate	Moderate to Heavy (Class 3)
Indian Creek	150	10.1	moderate	Moderate to Heavy (Class 3)
Ormes Peak	36	3.1	moderate	Light (Class 2)
Totals for Other Locations	72	21.2	moderate	Moderate to Heavy (Class 3)
SUMMARY	348	16.5	moderate	Moderate to Heavy (Class 3)

[1] See Figure 3 for survey locations

[2] Table 1 explains defoliation classes

Figure 4. Areas Surveyed for Western Spruce Budworm on the Roosevelt National Forest

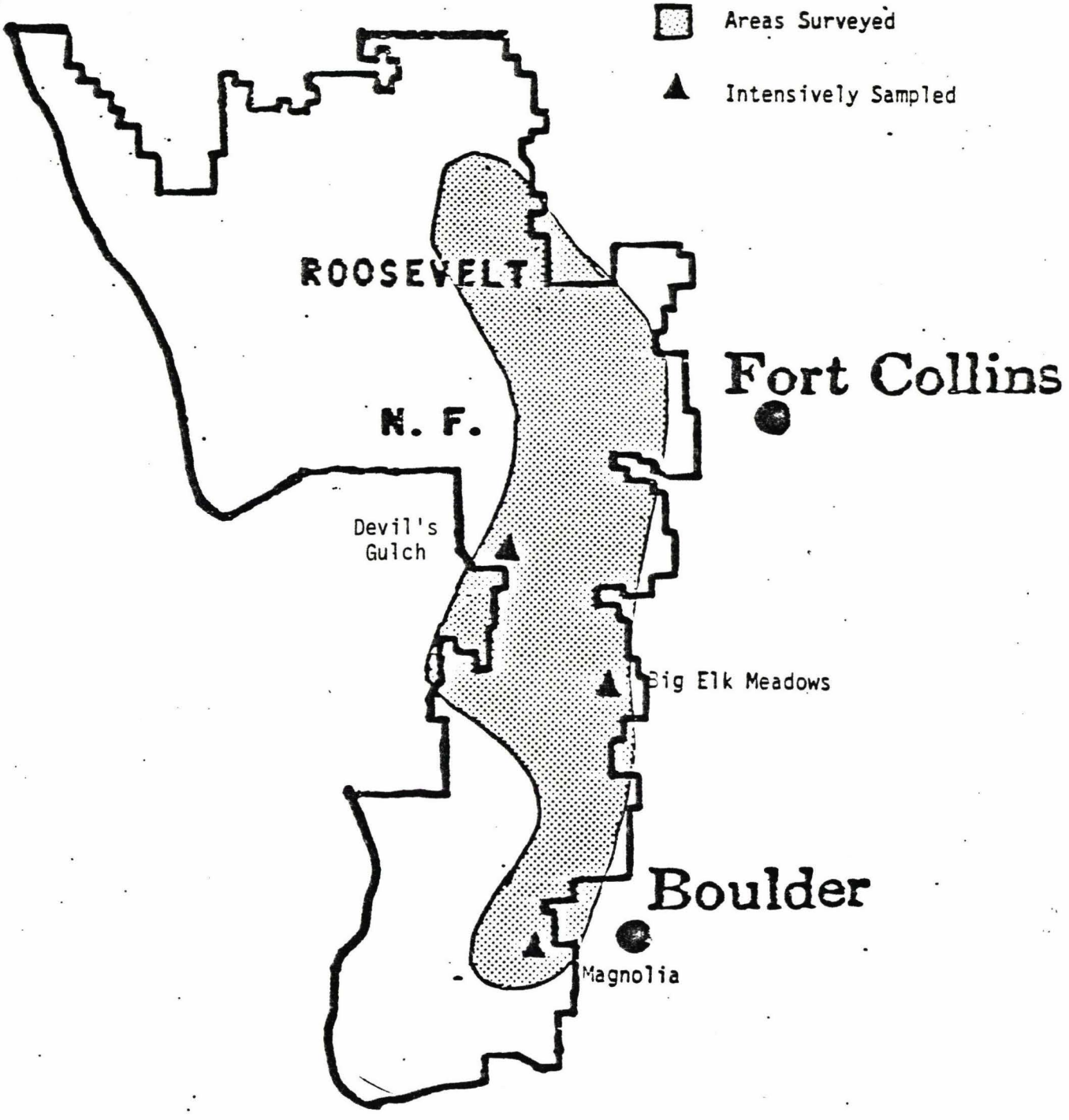

TABLE 4. Results of Western Spruce Budworm Egg Mass Sampling on the Roosevelt National Forest

Area [1]	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage	1979 Defoliation Estimate	1980 Defoliation Prediction [2]
Big Elk Meadows	120	41.9	Heavy	Moderate to Heavy (Class 3)
Magnolia	60	9.1	Moderate	Light (Class 2)
Devil's Gulch	30	23.2	Heavy	Moderate to Heavy (Class 3)
Totals for Other Locations	108	18.9	Moderate	Moderate to Heavy (Class 3)
SUMMARY	318	25.8	Moderate to Heavy	Moderate to Heavy (Class 3)

[1] See Figure 4 for survey locations

[2] Table 1 explains defoliation classes

Egg mass densities have not changed significantly from 1978 with the exception of the Big Elk Meadows area which increased substantially. Cumulative defoliation (1974-79) is severe in many areas. Top-killing and some tree mortality, particularly in < 5 inch d.b.h. classes, is apparent in severely defoliated Douglas-fir stands on poor sites. In 1980, defoliation may be moderate to heavy in the Douglas-fir type.

RECOMMENDATIONS

Resource managers have basically two alternatives in managing budworm infested lands. Where management objectives warrant, the first alternative is direct control. The second is no action. Silvicultural management of susceptible stands, often indicated as an important tool in reducing losses to forest insect pests, has not been adequately investigated in the central and southern Rocky Mountains for practical application.

The first alternative, direct control, involves aerial or ground applications of either a chemical or a microbial insecticide. Currently, aerial insecticidal applications cost approximately $6.75 per acre for a chemical pesticide (i.e. Sevin-4-Oil). Aerial applications of a microbial insecticide (i.e. *Bacillus thuringiensis* formulations) may be more expensive. Individual tree protection with ground applied insecticides may approach $6 per tree. Any insecticidal control project involving the western spruce budworm may require annual applications to achieve protection throughout the duration of the infestation. Considering the timber values of budworm susceptible stands within the Region, it is not likely direct treatment of the budworm can be justified on timber values alone. However, protection from budworm defoliation may be desirable and feasible within high value or high use areas, such as campgrounds, picnic grounds, other developed recreational areas, areas of scenic value, Christmas tree production areas, and other areas of high aesthetic value. These areas would need to be identified, the impact of defoliation determined, and an economic analyses applied. FI&DM can assist land managers with these analyses.

Currently, Sevin-4-Oil, Cythion ULV (malathion), Orthene, Sevimol 4, and some *Bacillus thuringiensis* formulations (Dipel®, Thuricide®, etc.) are registered with the EPA for aerial application against the western spruce budworm. Sevin-4-Oil, Sevimol 4, *Bacillus thuringiensis*, and Kryocide are registered as ground-applied insecticides.

The second alternative, a no action approach, may result in varied amounts of tree deformity, seedling damage, seed destruction, and poor regeneration in severely infested stands. Severe and continued defoliation throughout the duration of the infestation may cause top-killing and some tree mortality. However, the greatest impact of budworm defoliation may be in high use and high value areas, where losses in aesthetic values may be a direct result of budworm infestations.

LITERATURE CITED

McKnight, M. E. 1967. Ecology of the Western Spruce Budworm, Choristoneura occidentalis Freeman (Lepidoptera:Tortricidae), in Colorado. Colorado State Univ., PhD Thesis, 1967. Entomology.